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An Evaluation of Factors Affecting Livability in a Freight-Centric Community in Memphis, Tennessee

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AN EVALUATION OF FACTORS AFFECTING LIVABILITY

IN A FREIGHT-CENTRIC COMMUNITY IN MEMPHIS, TENNESSEE

by

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Abstract

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Community livability is increasingly being examined and promoted as exemplary practice. The impact of freight on an urban community is significant, yet in the United States few efforts have been devoted to better understanding the concept. A pilot-scale project was conducted in Memphis, Tennessee in a region with heavy freight traffic. Following a broad literature review of globally applied strategies for enhancing livability and solving problems caused by freight, a survey was conducted of various residential stakeholders regarding their perceived definition of livability, barriers to livability, and impact of freight on the livability of their communities. Survey results were analyzed to identify priorities for a livable community and to explore the differences between freight-centric and non-freight-centric responses. Transportation related strategies that may provide a way to enhance livability were also evaluated based on their applicability in Memphis, Tennessee as well as their general applicability and effectiveness in the United States.

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Introduction

Numerous definitions of livability exist among the various stakeholders in a community, whether from the residential, industrial, or political perspective. Even among residents, the basic qualifications of a livable community may change drastically. The principles of livability according to the Federal Highway Administration include the availability of many transportation choices, equitable and affordable housing, enhanced economic competiveness, support of existing communities, coordinated federal policies and investment, and an increased value for communities and neighborhoods (ICF International, 2011). Not only may the definition and priorities for livability vary among stakeholders, but they may also shift depending on an emphasis in the economic, social, or environmental aspects of livability for a community. This research is focused on the overall residential perception of livability and aims to identify barriers to livability for a specific type of community with a heavy freight presence. In addition, this work identifies alleviating technology-based or strategy-based methods that may enhance livability as an evaluation of each method's effectiveness and applicability is performed.

As they provide a "permanent source for inefficiencies," the ever-changing, intangible mixture of conflicting and overlapping needs of all the urban transportation constituents (freight carriers, passenger cars, transit participants, local business owners, urban residents, etc.) requires adequate planning and consideration when trying to achieve increased livability (Munuzuri, Larraneta, Onieva, & Cortes, 2005). Furthermore, many communities change immensely in response to increased freight traffic and are put at higher risk for issues associated with the movement of freight. This type of community is the subject of this research and is considered to be a "freight-centric community." A freight-centric community is distinguished as having a high percentage of freight traffic/freight-producing facilities. A freight-centric community is also defined by a lack of a substantial buffer area between a freight generator and a residential area.

Methodology for this research was implemented along the Lamar Corridor in Memphis, Tennessee, and it employed the use of surveys and public forum discussions to better inform the research team about the hindrances to livability within the region. The Lamar Corridor is a 6.5 mile long corridor in southeast Memphis, TN. The segment being evaluated connects I-240 to the north to E Holmes Drive to the south (see Figures 4 and 7). The area surrounding Lamar Avenue (or US 78) has a heavy industrial presence and is therefore very intensely populated with freight traffic. Some of the main freight producing facilities that are within this study area include the Burlington Northern Santa Fe (BNSF) rail yard, FedEx Hub, and the Memphis International Airport. In addition to these land uses, there are also many warehouses, commercial uses, and office spaces present (Cambridge Systematics, 2011). No adequate buffer exists between these and the residential land uses in this area, therefore, this part of Memphis is considered a freight-centric community. Furthermore, because of its makeup, this region is considered a trade node and thus possesses the related types of freight problems (Giuliano, O'Brien, Dablanc, & Holliday, 2013).

In order to enhance livability in a given urban region, one must first understand the area-specific impedances to the concept, from any of the perspectives mentioned above. Data and observation (despite a noted lack of freight data), as well as literature, may be used to make assumptions about barriers to livability in a given region, but this research ultimately identifies a representative perception of livability from the viewpoint of its residents. A survey instrument was developed that provided information about residential perspectives and priorities for improving livability along the Lamar Corridor. This survey was administered to population of residents from both the freight-centric (FC) community and the non-freight-centric (NFC) community. The results of this survey informed the area-specific barriers to livability for each group, and a statistical comparison analysis was performed in order to determine if a significant difference existed among the two groups. Numerous strategies to enhance livability were identified from literature, and ultimately they were evaluated based on their relevance to the specific case in Memphis, Tennessee. Many of these alleviation techniques have already been implemented in other parts of the US and the world. Most of the experimental techniques have been implemented in Europe, so it is crucial to study the effectiveness of these, as well as the possibility of reasonably and legally transferring these strategies for US implementation (Dablanc, Giuliano, Holliday, & O'Brien, 2012). Overall, the purpose of this research is to identify a set of best practices to improve livability in freight-centric urban areas throughout the United States by trying to improve understanding of livability from the residential perspective. Ideally, the work done in Memphis, TN will be built upon and also applied to similar FC areas in the United States.

A review of literature included in this research provides information regarding how freight changes an urban area, suggested policy solutions and industry practices that may impact livability, available strategies or advanced technologies that may improve livability, as well as suggestions for measuring success in enhancing livability.

Literature Review

Inherent to the global roadway system are the problems of traffic congestion, air pollution, and noise pollution, as well as the potential for traffic accidents; all of which are amplified by the addition of necessary yet cumbersome freight traffic. Densely populated urban areas put increased demand on the US freight transportation system, one of the most expansive in the world. Research on (and attention to) the heavy presence of freight in urban areas was slow to come, but it is becoming increasingly necessary that consideration be taken to mitigate freight's effect on urban livability (Browne, Allen, Nemoto, Patier, & Visser, 2012; Lindholm, 2010; Long & Grasman, 2012). Each of the negative impacts shown in Figure 1 weakens the livability of an urban area.

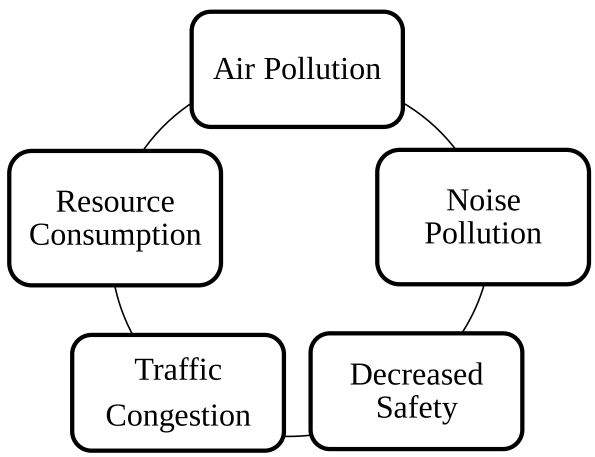


Figure 1 Externalities of Urban Freight Transportation (adapted from Browne et al., 2012)

More specifically, the common issues faced by urban areas and freight transport are described by Maria Lindholm (2012) as:

- *Traffic flow/congestion problems - Caused by high traffic intensity, insufficient road infrastructure and poor preparatory work*
- *Transport policy-related problems - Limited access for vehicles, based on hour of the day and/or size, weight of the vehicle*

- *Parking and loading/unloading problems - With regulations, charges, lack of loading zones and handling problems of goods*
- *Customer/receiver-related problems - Including queuing for delivery and reception, difficulties finding receiver and adapting to the receivers' demands on delivery and pick-up (136-137).*

After further classification of these types of freight problems is presented, the possible solutions currently proposed in literature will be explored. In some cases, these measures are being executed in Europe and the US, so certain case studies will also be presented and will include specific results and examples of cargo-oriented development. Finally an introduction of possible indicators and metrics for quantifying success in reinforcing livability in these regions will be presented.

A Classification of Freight Problems in Urban Areas

As population increases and cities grow denser, there becomes an increased need for freight mobility. Furthermore, as cities grow, space becomes more and more limited, while the demand for this space becomes greater as more goods and deliveries are required (Dock, Benedict, & Chandler, 2008; Goldman & Gorham, 2006; Lindholm, 2010; Munuzuri et al., 2005). Those cities or regions with freight hubs, intermodal transfer points, air ports, or other mass freight generators are known as "trade nodes," and the issues that arise from the higher concentration of freight traffic at these locations are known as "trade node problems" (Giuliano et al., 2013).

Current global trends dictate increased shipments worldwide, as well as a much higher requirement of "just-in-time" goods (Allen, Browne, & Cherrett, 2012; Dock et al., 2008; Long & Grasman, 2012). Because of the increasing demand for these types of deliveries, freight loads are not as efficiently packed and trucks are more often traveling empty or below capacity (Goldman & Gorham, 2006). Additionally, access restrictions, spatial restrictions, and congestion may cause delay for the same trucks that face increased pressure to make deliveries/pick-ups on time. These factors fuel a type of freight problem known as “last-mile/first-mile” problem (Giuliano et al., 2013).

Another livability issue for freight is its impact on the environment; studies show that a concentrated presence of freight in cities “contributes disproportionately to congestion, noise, and road accident fatalities” as they yield a significant amount of NOx, PM, and CO_2 emissions (Giuliano et al., 2013). Pollution is more present in freight corridors, ports, and warehouses, and is a direct result of the increased presence of freight (Giuliano et al., 2013).

It has also been reported that “de-industrialization” occurring in the UK has redistributed industry locations (and consequently industrially related freight movement) to international locations, thus amassing more international port traffic and congestion in the US (Allen et al., 2012; Long & Grasman, 2012). Projections show a 70% increase in freight volumes throughout the US by 2020, so there exists an ever increasing need to promote livability and sustainability, as well as general functionality. Positive economic development depends upon highly functional freight transportation networks (Long & Grasman, 2012).

Suggested Freight Solutions & Initiatives that Impact Livability

Of the numerous suggested ways to organize alleviation techniques, the following divisions are used here: (1) public infrastructure, (2) landuse and logistics management, (3) access conditions, (4) traffic management, and (5) trade node. Each of the initiatives for mitigating the inherent problems of increased freight volumes will be presented under these divisions. Methods dealing with infrastructure, consolidation, and access restriction may be handled by local authorities and policy makers, while specific vehicle enhancements (like efficient engines or aerodynamic vehicles) or technological solutions could by implemented in industry (Browne et al., 2012; Lindholm, 2012; Munuzuri et al., 2005).

Public Infrastructure

It is shown that the optimization of a network of transfer points both within a city center and on the outskirts will drastically improve the efficiency of the overall goods movement system. Properly located terminals stimulate efficiency by allowing the consolidation of trips and goods for one company or collaboration. The resulting improved organization may allow for the incorporation of better modal options, such as transitioning to rail, shuttle, waterway canals, or an underground system (Lindholm, 2012; Munuzuri et al., 2005). Transitioning to rail or boats from trucks often increases costs and requires subsidization (Giuliano et al., 2013). Well-located hubs that allow for direct transition from trains to delivery vans are preferable (Lindholm, 2012; Munuzuri et al., 2005).

The creation and utilization of centrally located urban distribution hubs (that also potentially incorporate clean-energy delivery vehicles) is known to reduce the frequency of inner-city truck trips (Goldman & Gorham, 2006). These Urban Consolidation Centers (UCCs), also known as urban distribution centers, are typically set up in parking lots or other empty or shared spaces where freight vehicles may unload cargo to smaller delivery vehicles. The presence of an inner-city terminal or hub may help alleviate congestion by decreasing trip frequency and minimizing total vehicle miles travelled, as well as encouraging consolidation of trips and improving the efficiency of loads (Browne et al., 2012; Munuzuri et al. "Solutions applicable" and "Selecting the location").

This methodology is considered by some as one of the most all-encompassing and successful techniques (Lindholm, 2010). Others, however, have reported this method to be "economically unfeasible" after a test period and the conclusion of external funding (Munuzuri, Cortes, Grosso, & Guadix, 2012). Even in densely populated cities, however, transport hubs are known to provide economic benefits (Lindholm & Behrends, 2012).

Another strategy would be to incorporate the use of "Alternative Fuel Vehicles" or AFVs. This strategy could be applied to transit busses or industry constituents that have large fleets (e.g., Fedex or UPS); such companies are exploring the use of AFVs in both the US and Europe, though hindrances AFV use do exist. AFV usage includes the necessity of capital and higher operational costs, as well as limited infrastructure for their re-fueling. In fact, diesel engines may still prove to be advantageous over AFVs, especially for larger trucks (Giuliano et al., 2013).

It may be appropriate to adapt a current transit (tram or underground) system to incorporate the movement of freight, despite potential for costly or timely modifications. The advantages of improving an already-existing infrastructure as well as the potential to decrease above ground congestion may validate the process (Munuzuri et al., 2005).

Land use & Logistics Management

City Logistics Management

Muñuzuri et al. (2005) define city logistics as “the specific logistic concepts and practices involved in deliveries in congested urban areas, the ‘last mile’ transport, with specific problems such as delays caused by congestion, lack of parking spaces, close interaction with other road users, etc.” (2005). In response, it is suggested that where possible parking lots left unused for time periods be temporarily converted to loading/unloading zones as a means to take heavy vehicles off streets, thereby reducing delay and congestion. Furthermore, the creation of designated parking spots for heavy vehicles, where a driver may park for a longer period to deliver his goods on foot or dolly, would serve to decrease noise, air, pollution and congestion.

Neighborhood Logistics Management

In an effort to minimize the necessity for under-capacity loaded trucks, it is suggested that neighborhoods/local regions designate one uniform package pick-up location (Goldman & Gorham, 2006). This concept would remove time restrictions, as the receivers would not need to be present; nighttime deliveries would also become appropriate. Such a method is especially applicable in dense areas that receive a high number of packages (Munuzuri et al., 2005).

Construction Logistics Management

Berlin experienced massive success with the construction logistics management they practiced redeveloping Potsdamer Platz. For example, policy was in place that mandated concrete be mixed on-site, as well as that the majority of materials be moved by rail. The resulting efficiency encouraged the establishment of national policy requiring major construction jobs to include logistics management (Goldman & Gorham, 2006).

Land Use

Even though the delineation of specific loading/unloading zones per destination is common practice in many cities worldwide, demand for them is increasing, and it is recommended that building regulations be updated to include accommodation for off street loading. In extreme cases such as on narrow or one way roads where loading is still necessary, proper consideration, such as signalization and/or premeditated regulations, should be used when blocking traffic, and only for short periods of time.

Although the idea may be met with opposition by certain stakeholders, it is known that in some cases traffic congestion could be lessened by removing on-street parking altogether. This method would be supplemented well by adding alternative parking lots or transit options, but is still controversial. Success exists for carriers who have learned to share land, space, and technologies. It is suggested that carriers collaborate in shipping hubs in order to jointly benefit from the space or technology. Furthermore, while the specification for reserved space (like private, handicap, motorcycle parking, and taxi and bus lanes) is crucial for the functionality of urban systems, they are often left empty for periods of time. When these empty slots align with peak freight delivery periods, sharing would induce beneficial results (Munuzuri et al., 2005).

Access Conditions

As some of the first measures to be implemented in most European cities, these kinds of methods are already heavily used in Europe. The specifics vary, but benefits have been reported in many cities (Lindholm, 2012). Access may be controlled through a variety of measures, whether based on weight, volume, size or other load capacity factors (Munuzuri et al., 2005). Disallowing the entrance of highly emitting vehicles in certain “zones” should have a positive impact on the environment (Lindholm, 2010). Also known as LEZs (Low Emission Zones), these restrictions are claimed by some to inspire the complete reorganization of freight operations with more effective results (Giuliano et al., 2013). In the Netherlands, however, results were less than anticipated. Although, this outcome could be due to an excess of permits allowing access of poorly rated vehicles (Browne et al., 2012). Numerous European cities have previously experienced diminishing harmful emissions by restricting admittance of old/out of standard heavy vehicles into inner-city areas (Goldman & Gorham, 2006). It is important to note, that while benefits of LEZs are apparent, the transferability of these to the US is limited (Giuliano et al., 2013).

Another type of access condition is based on time of day. It is easy to see how restricting delivery/pick-up within congested urban areas to off-peak time periods could help minimize freight’s externalities. Furthermore, as trucks are present during night time or uncongested daytime periods, more parking or loading/unloading areas should be available (Munuzuri et al., 2005).

Traffic Management

Due to variability among freight vehicles and companies, as well as urban regions, distinctions should be made to accommodate for varying needs of an urban transportation system. Classifications may be made as follows:

Freight vehicle characteristics

- Based on the percentage of full capacity of a given vehicle, a proportionate amount of time may be allowed for loading/unloading.
- Vehicles making multiple deliveries on a route should be allowed less time in any one zone, as opposed to vehicles making one stop and emptying a majority of their load.
- Access will vary based on content of load—depending on weight or size of goods to be delivered (Munuzuri et al., 2005).
- As one of the most effective measures, strict emissions standards for fuel efficiency of trucks proves to have a significant influence on freight's impact. For example, "The Los Angeles/Long Beach Ports Clean Truck Program is by far the most ambitious emissions reduction program in the United States and, in 4 years, led to large reductions in diesel truck emissions." A sustainable option as well, fuel efficiency of freight and emissions standards will continue to negate air pollution and carbon dioxide emissions in urban areas (Giuliano et al., 2013).

Delivery zone characteristics

- Symptomatically based solutions will vary depending on delivery region (tourist, residential, commercial, or a combination of these).

- Depending on the nature of delivery destination, night time delivery may not be appropriate (Munuzuri et al., 2005).
- Access to certain areas may be granted for trucks achieving a specific label or status. For example, cleaner emissions or minimal noise outputs may earn a truck access to a particular area (at a particular time). Such strategies are typically voluntary and would serve as useful ways to incentivize livable results for residents (Giuliano et al., 2013).

Street characteristics

As they specifically relate to freight operations, these categories consider aspects such as land use availability, a potential for shared space in proximity, the width and number of lanes, and the proximity to non-residential areas to classify urban streets as either:

- Access Streets
- Restricted Access Streets
- Load/unload streets
- Non-freight streets
- Pedestrian streets

Consequently, it may assist freight distributing agents already facing numerous restrictions to consolidate basic strategies, where appropriate, across urban districts. Many of the previously mentioned methods for enhancing livability for urban residents and other local stakeholders, hamper the abilities and flexibly of the freight distributors themselves, while increasing their costs. The location of logistics hubs is important, and properly locating an inner-city freight or “minihubs” can combat these effects for industrial stakeholders as they must maintain their mobility and effectiveness in the end.

Minihubs differ from UCCs in that they do not require substantial funding (Munuzuri et al. “Solutions applicable” and “Selecting the location”). There exists a discrepancy in the literature on specific results of many of the methods mentioned here and practiced in various European cities (Lindholm, 2010).

Intelligent Transportation Systems (ITS)

Policy makers and industrial constituents may utilize the above classification schemes in combination with various technology-based techniques to help manage traffic. Intelligent internet and surveillance based reservation systems for loading/unloading, as well as the dissemination of information about other “real time” traffic situations provide valuable information to freight vehicles and controllers that could help alleviate delay, congestion, and higher costs. This is similar technology to the kind used to coordinate traffic signals and combat accidents in other intelligent transportation networks (Munuzuri et al., 2005). The NCFRP Report 23 provides the following definition, “ITS for monitoring or managing urban freight includes technologies for providing real-time traffic (and parking) information, automated enforcement of parking or traffic regulations, automated toll collection, and automated access control.” ITS technologies incorporating GPS tracking of fleet vehicles or individual parcels are considered private initiatives (Giuliano et al., 2013).

While real-time traffic information is being utilized in larger US cities, the UK, Spain, and Italy are currently more progressive and are using license plate scanners to monitor truck traffic. The US is continuously enhancing the technology used in national ITS measures, and the largest private shipping companies are even more advanced in their internal monitoring. Intelligent parking management strategies are slower to progress, and high cost and complicated systems are claimed to be the biggest obstacle for these methods. Despite an increased initial cost for automatic enforcement systems, ITS like these may sustainably decrease the monitoring of tolls or access-restricted zones. The applicability of such systems in the US, however, is questionable and further exploration is needed. (Giuliano et al., 2013).

Trade Node Solutions

Defined as including significant freight producing facilities such as ports, airports, or intermodal yards, trade nodes not only see the freight problems associated with urban last mile/first mile transactions, but they also see the additional problems associated with an increased concentration of freight traffic (Giuliano et al., 2013). The following strategies pertain specifically to trade node freight problems.

Appointments and Pricing Strategies at Ports

In an attempt to better organize freight arrivals at ports or intermodal facilities, gate appointment strategies have been implemented in limited locations in the US. A successful example a pricing strategies in California shifted 40% of its freight cargo to the evening. This spacing of concentrated freight traffic should reduce congestion in nearby corridors.

While the necessity of fees for peak-hour interactions is not yet prevalent at many trade nodes in the US, the implementation of such could also serve to spread concentrated freight arrivals in congested corridors.

Road Pricing and Dedicated Truck Lanes to Manage Hub-Related Truck Traffic

Such strategies are sparsely found in practice, and much more research is needed to comment on their effectiveness. These strategies include tolls for freight traffic and/or the designation of certain lanes or roads for freight traffic only.

Increased tolls for freight trucks would reduce truck competiveness compared to rail, and thus would benefit the personal vehicle user, as well as the environment. The increased cost to the freight carrier, however, may prevent the rapid acceptance of freight tolling in the US. Furthermore, freight-only lanes are rarely found in the US, and the cost and land requirements are high and normally unjustified by the volume of freight traffic.

Accelerated Truck Emissions Reduction Programs

To further the emissions standards mentioned above, these programs aim to reduce the average age of freight vehicles travelling through certain zones or trade node sites. Such strategies incentivize the replacement of older, poorer emitting vehicles with newer, cleaner ones.

Equipment Management

These strategies incorporate increased management of chassis and cargo containers to improve their use and movement within freight transfer operations. With an overall goal to reduce VMT, such strategies would also reduce congestion and emissions.

Rail Strategies

These strategies incorporate grade separations at rail sites, but also include high capital costs. Currently in the US, no funding exists for such projects.

Border Crossings

These strategies typically include the use of ITS measures at locations where freight traffic crosses borders. Room for improvement of ITS at borders exists.

Unlike solutions mentioned in previous sections, trade node solutions have typically been executed in US locations. Of the above solutions, the road pricing and accelerated emissions programs are expected to be the most useful in promoting livability by reducing emissions and congestion (Giuliano et al., 2013).

Of the previously mentioned solution types, the three most successful and easily applicable in the US are: (1) labeling and certification programs, (2) land use planning polices, and (3) truck fuel efficiency and emissions standards.

Global Case Studies and Cargo Oriented Development

While exploring various remedies to the negative impacts of freight in communities, the European Union developed and encouraged the use of a systematic planning process called the Sustainable Urban Transport Plan (SUTP). This program relies on and encourages continuous collaboration between the various stakeholders in a community through its comprehensive and ongoing process (see Figure 2) (Lindholm, 2010; Lindholm & Behrends, 2012).

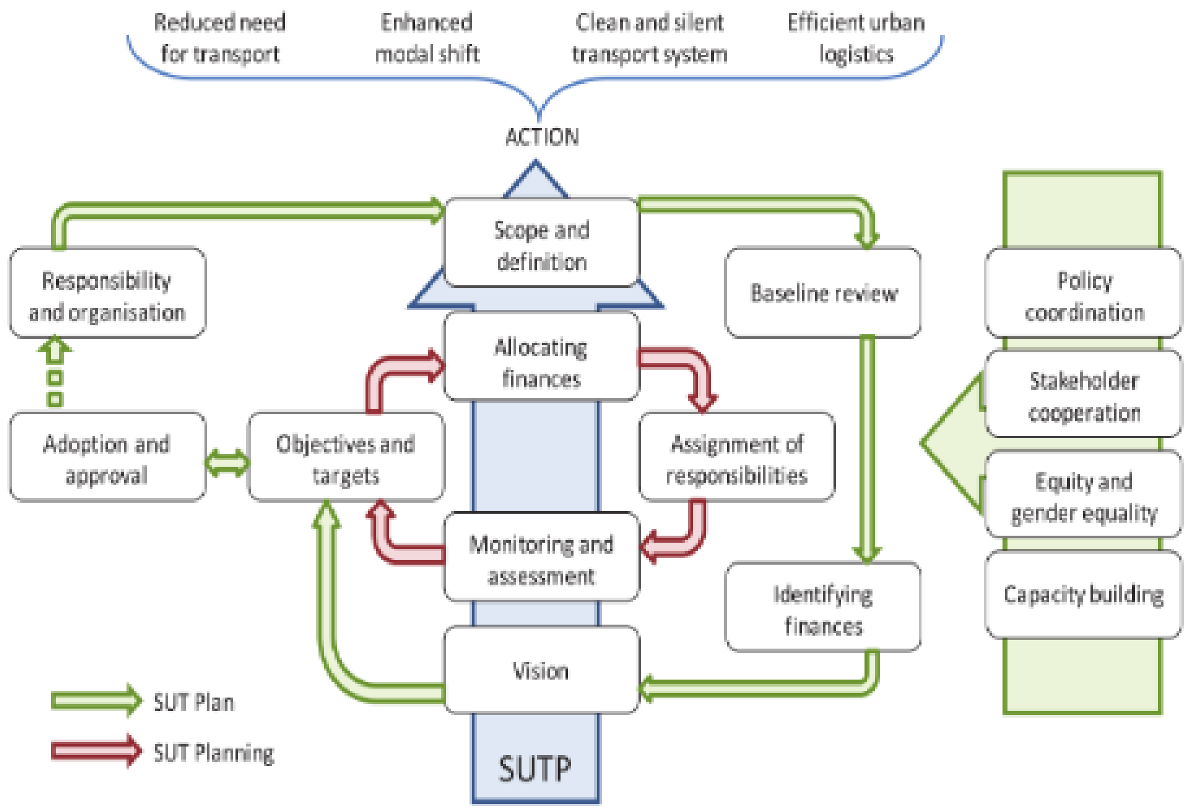


Figure 2 The SUTP Map (Lindholm, 2010; Lindholm & Behrends, 2012)

London

Beginning in 2000, a wide range of the previously mentioned solutions were carried out and analyzed in London, with a focus on reducing harmful emissions. The Mayor's directive, Transport for London (TFL), and its Freight Plan, worked toward specific goals aligned with improving livability. First of all, the Freight Operator Recognition Scheme (FORS) provided education by means of free training workshops and informative guides that would encourage environmental and operational efficiency. Delivery and Servicing Plans (DSPs) and Construction Logistics Plans (CLPs) also existed to help optimize freight flows and encourage the proper use of loading zones, thereby reducing pollution and congestion, as well as improving safety conditions. These plans reported a 20% reduction in the number of deliveries to a test site (over an unspecified period of time).

Furthermore, the London Construction Consolidation Centre (LCCC) was launched as a two year pilot program. Serving four different locations with direct, just-in-time delivery from suppliers (while limiting storage time), this project was able to report a 60-70% decrease in the number of vehicles delivering to major construction sites. Finally, the City of London Urban Consolidation Centre, created by a local office supply corporation, employed the use of electrically powered vans and tricycles to report a complete reduction in fossil fuel consumption and a 20% decrease in total distance to delivery sites (Browne et al., 2012). Both Lindholm (2010) and Browne et al. (2012) attribute the success in London to the willingness and proactiveness of city policy makers, as well as other stakeholders.

Japan

As a collaborative effort instigated by approximately 300 local shop owners on Motomachi Street in Yokohama, and partnering with the city's government and police forces and the Kanagawa Trucking Association, this consolidation centre (depicted in Figure 3) is the first of its kind in Japan. With a focus on air and noise pollution reduction, this effort aimed to reduce heavy congestion on its busy main street. After thorough research and planning, the centre was constructed in 2004 and operates as shown in Figure 3 (Browne et al., 2012).

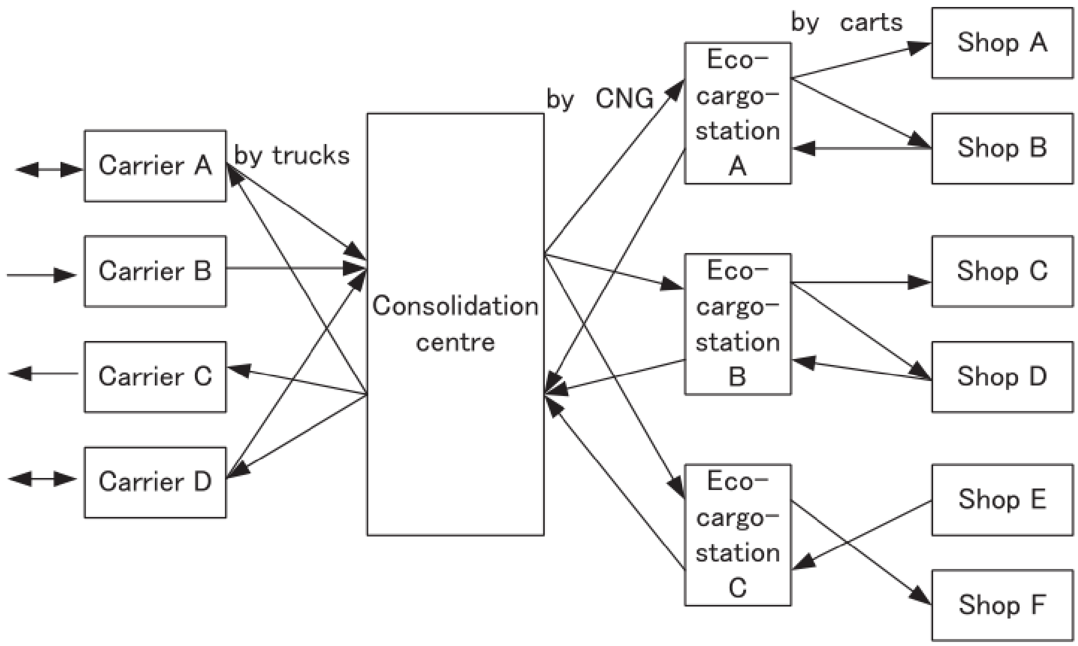


FIGURE 3 UCC Layout and Delivery System in Japan (CNGs are compressed natural gas vehicles)

Cargo Oriented Development

South of Chicago, a method of Cargo Oriented Development (COD) is being explored as the South Suburban Mayors and Managers Association (SSMMA), Chicago Southland Economic Development Corporation (CSEDC), and the Center for Neighborhood Technology (CNT) collaborate in an effort to utilize empty, previously industrialized "brownfields" for locating freight distributing companies in an effort to catalyze economic development. This region is especially favorable because of the availability of this type of developable land, as well as the fact that vehicle, rail, and barge traffic all come together here (a quality preferable when executing COD practices). Quantitative and thorough analysis was conducted, along with regimented comparisons of 598 sites incorporating variables of land use and characteristics, transportation amenities, current presences of businesses, and local demographics (Dock et al., 2008).

A specific approach for the evaluation of the efficiency of inland hubs (not necessarily urban) was developed by Long and Grasman, and is possibly applicable to other urban-related situations. To develop their evaluation techniques, they interviewed eighteen professionals in the intermodal transportation field, and the following criteria were established:

Table 1 Summary of Criteria Identified by Subject Matter Experts (Long & Grasman, 2012)

Criteria	Description	Measurement Method	Data sources
Infrastructure	Capacity to move freight access to transport modes	Identify highways, railroads, waterways, airports, and multimodal terminals	Infrastructure maps, US Dept. of Transportation
Proximity to market	Market reach, one-day market reach	Find population within 600 mile radius of alternative region	US Census Bureau
Land availability	Land available for transportation logistics development	Identify vacant land, buildings/land available for re-development, etc.	Region-specific real estate data
Government and industry support	Government support of transportation developments and size of regional transportation/ distribution industry	Identify regional economic development councils, especially those with transportation emphasis. Find the number and size (by revenue or employment) of local industry.	Region-specific data on government organizations and industries
Labor supply	Industrial labor supply able to meet expanding transportation developments	Identify the proportion of a region's workers that have the skills for transportation jobs	Bureau of Labor Statistics

Table 1 Summary of Criteria Identified by Subject Matter Experts (Long & Grasman, 2012)

Criteria	Description	Measurement Method	Data sources
Origin/ destination distances	Distance between freight flows to and from a region	Use freight flow data to compare the near optimal location with the region's actual location	Freight Analysis Framework, FHWA
Congestion	Delays in freight movement cause by congested traffic	Use congestion indices to measure congestion levels of freight significant corridors. Other corridors will require primary data collection from local experts.	American Transportation Research Institute

These specifications could indicate the sustainability and overall effectiveness of freight hubs.

Factors/Metrics for Success

It is important to consider the macroscopic system in which a given urban network is found. It is argued that the incorporation of the external effects of surrounding transportation systems, as well as the extent of human and economic variability, when planning for local, urban networks is crucial for successful policy making (Goldman & Gorham, 2006). Both the concepts of livability and sustainability are vague and multifaceted; therefore their ability to be measured is complicated. The process should be done carefully in order to apply the results in policy making (Miller, Witlox, & Trippy, 2012). Urban transportation systems are said to be classified by the following characteristics (Browne et al., 2012):

- Infrastructure for transport (type and quality)

- Proportion of vehicle as mode chosen
- Prevalent traffic conditions
- “Degree in automation in vehicle loading/unloading and materials handling”
- Degree of government involvement in freight-directed policy
- Waste management layout and function

Factors already exist for measuring the livability in a general area. Miller et al. (2012) maintain: “quality of life, and sustainability measures and rankings [that] include scientifically-based policy measures such as the ecological footprint and the human development index and measures of inequality such as the Gini coefficient.” They dictate that further measures of livability should ensure consistency in assumptions, possess ability to be interpreted with ease, and be comprehensive in scope. It follows, that any process of measuring the livability of an urban area should consider the variability of the local conditions (whether based in local perceptions or policy standards) in order to attain validity (Miller et al., 2012).

It is important to note that there is a distinction between successes in sustainability of transportation systems; it may be achieved in the form of a final goal, or maintained as a continuous and constant track. Goldman and Gorham (2006) deem this concept as policy pathway vs. policy end-state. Both perspectives, however, include the use of “indicators” to quantify effectiveness: whether environmental (carbon dioxide, nitrogen oxides, ozone, particulates, and noise emission regulations), social (safety measures and statistics), or economical (delivery, fuel consumption, or capacity rates related to efficiency). Indicators such as measure of fuel emissions, load quotas and capacities, traffic flow measurements, etc. may be compared across multiple projects, as long as there exists a common base and evaluation method. When deciding what measures to operate with, it is important to keep in mind the current state of the problem for the specific location, and to keep multiple invested parties involved and educated. Additionally, it should be acknowledged that any decision may weigh differently among these stakeholders. To quote Maria Lindholm (2010, 2012):

A Sustainable Urban Freight Transport system should fulfill the following objectives:

- *Ensure accessibility offered the transport system to all categories of freight transport;*
- *To reduce the air pollution, greenhouse gas emissions, waste and noise to levels without negative impacts on the health of the citizens or nature;*
- *To improve the resource and energy efficiency and cost effectiveness of the transportation of goods, taking into account the external costs; and*
- *To contribute to the enhancement of the attractiveness and quality of the urban environment, by avoiding accidents, minimizing the use of land, without compromising the mobility of citizens (137).*

It is upheld that this definition combines the ideals of both a "pathway approach" and an "end state vision approach" and may be considered a complete definition of a livable and sustainable freight system.

Methodology

The overall goal of this research is to identify methods that may achieve improved livability for citizens living or working in FC communities like the one along the Lamar Corridor in Memphis, Tennessee. The study boundaries used to define the FC community are identified in Figure 4. The research objective was addressed by first identifying factors that are important for livability in both FC and NFC communities. A comparative statistical analysis of samples from each of these types of communities was then performed, and the results were used to inform conclusions regarding the relevance and applicability of measures identified from literature.

Background

Memphis, Tennessee contains three interstates, five Class I railroads, and one of the largest freight airport hubs in the world (Memphis MPO, 2014). A crucial part of the transportation infrastructure, Lamar Avenue (US Highway 78) sees a huge portion of the city's freight traffic. It serves as both a commuter route to downtown Memphis as well as a critical freight corridor with a many freight generating facilities**.** For this project, the portion of Lamar Avenue being evaluated in the context of a freight-centric community is a 6.5 mile-long corridor that runs from I-240 South to E Holmes Road and is shown in Figure 4 with the zip code boundaries included within the study area.

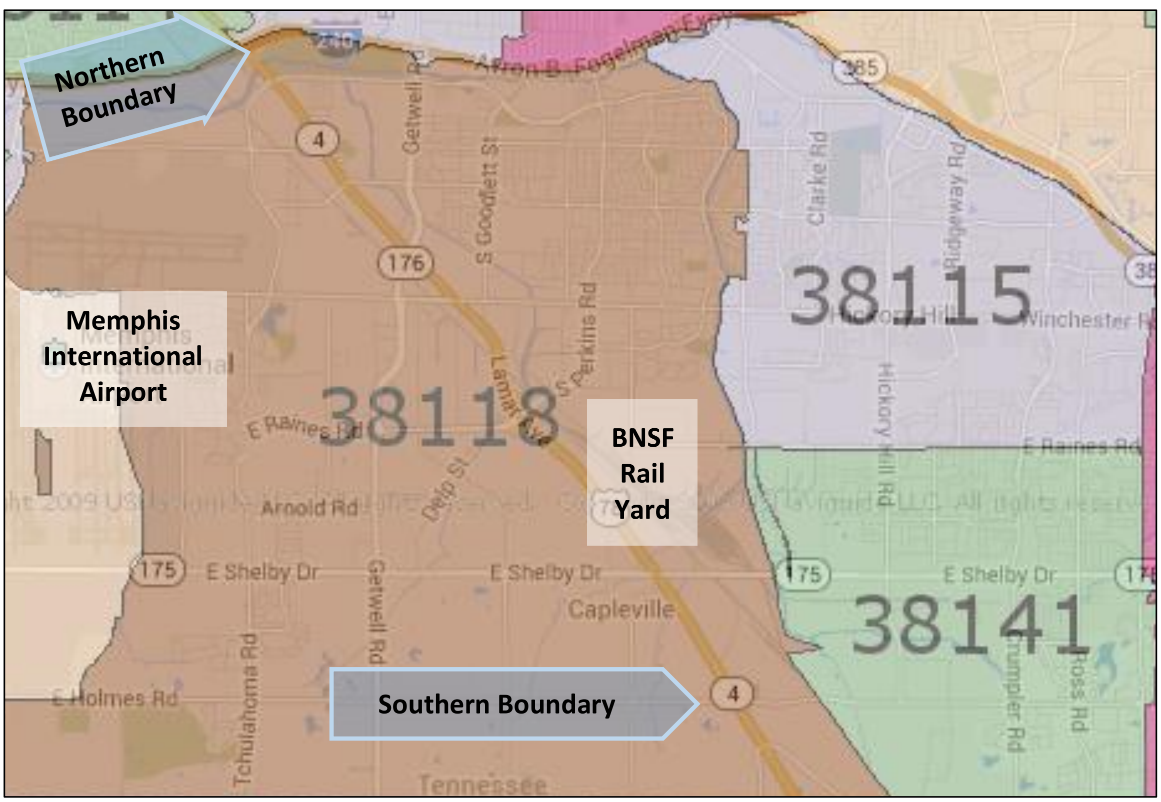


Figure 4 The Lamar Corridor Section Being Evaluated and the Zip Code Boundaries within the Study Area

Some of the major facilities and industrial sites that are within this study area include the Burlington Northern Santa Fe (BNSF) rail yard with a capacity of 300,000 twenty-foot equivalent units (TEUs) per year and parking for 6,000 trucks, as well as the Memphis International Airport, the second busiest air-cargo hub in the world due to FedEx. These facilities are highlighted in Figures 4 and 7.

Figure 5 serves as an indication of the dense population of freight generating facilities along the Lamar Corridor, thus defining the FC nature of the area.

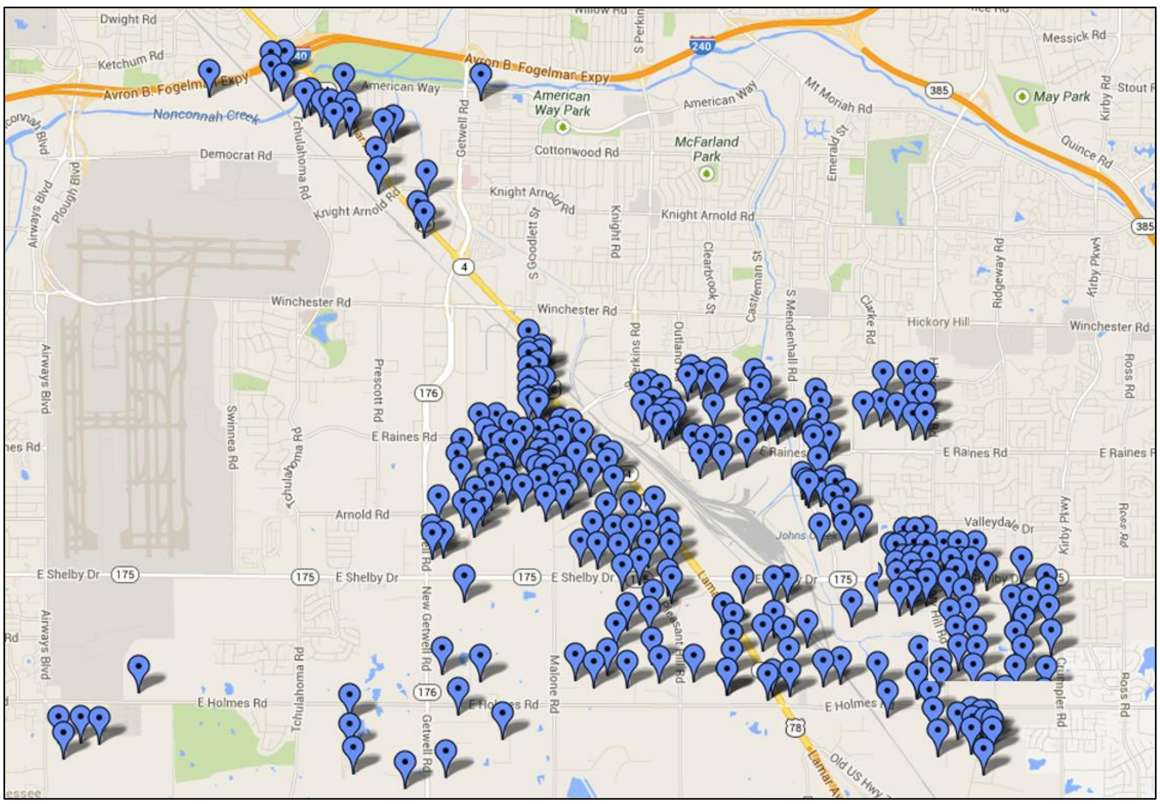


Figure 5 Location and Frequency of Freight Producing Facilities along the Lamar Corridor

Each point represents a building associated with freight movement or possessing a freight dock or facility. Truck volume on Lamar is found to be 8,000 average daily trucks constituting approximately 27% of the average daily traffic (Cambridge Systematics, 2011). In comparison, Figure 6 shows census tracks within the boundaries of the study area. For the 20 census tracks in Figure 6, the total population is 83,712 people as of 2010 (US Census Bureau, 2010).

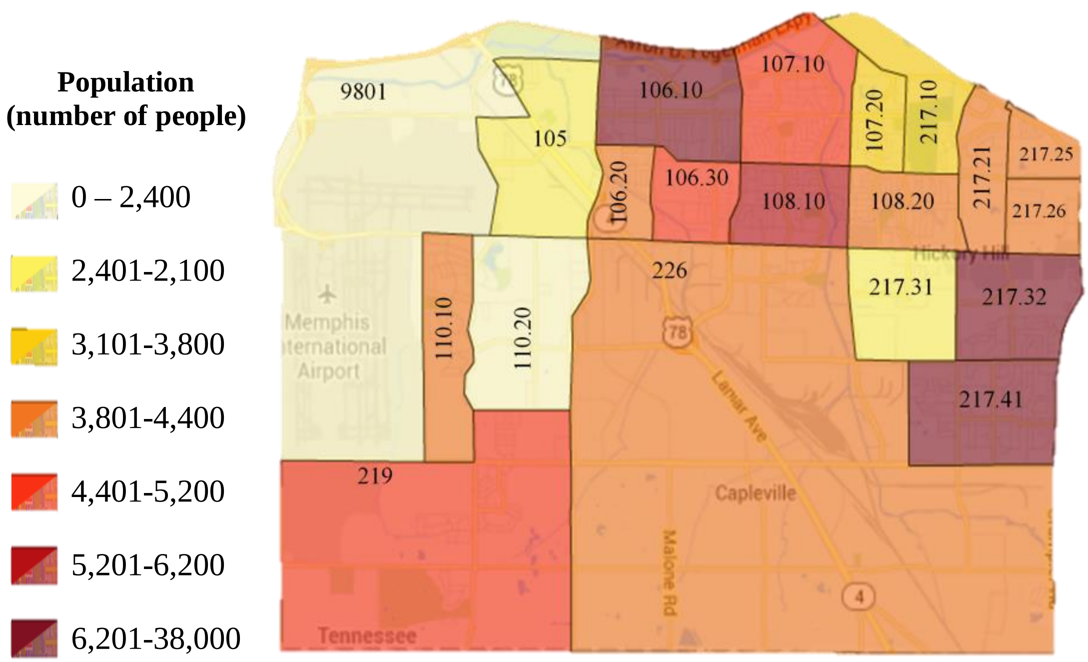


Figure 6 Population Data by Census Track (each census track is labeled on the map)

In 2011, within the study area, there existed more than 35,000 primary jobs. The highest percentage of jobs by Industry Sector was found in Transportation and Warehousing (14.2%), Health Care and Social Assistance (13.0%), and Waste Management and Remediation (12.4%). Of this population of workers, 80.1% are African American and 56.2% are female. A further analysis of data from the US Census Bureau from 2011 indicates the following regarding the overall inflow/outflow of workers within the selection area (living inside or outside of the analysis selection).

Table 2 Inflow/Outflow of Primary Workers, 2011 (US Census Bureau, 2013)

Number of jobs within study area (live inside or outside)	80,724
Number of workers living within the study area	35,009
Net inflow of workers (72,035 – 26,320)	45,715
Workers living and working within the study area	8,689

That is, 72,035 workers living elsewhere enter the analysis selection to work and 26,320 workers live within the selection and exit it to work elsewhere. The 8,689 workers that live and work within the analysis selection yield an "In-Area Employment Efficiency" of 10.8% within the study area.

The Lamar Corridor is primarily industrial with pockets of closed businesses and vacant rundown lots. Recent engineering studies have evaluated a number of infrastructure alternatives for Lamar Avenue. Completion of 1-269, an outer ring that connects to Lamar was an assumption in all alternatives, with the most effective in travel delay but costliest alternative being a conversion of the Lamar corridor to an interstate. The alternative with the highest benefit/cost ratio was the conversion of Lamar Avenue to a six and eight-lane road. Despite all the scenarios, findings also showed that by 2030 Lamar would again be congested (Cambridge Systematics, 2011). Thus, the communities surrounding Lamar Avenue are impacted by significant freight activity, can be defined as freight-centric communities, and serve as the basis for the analysis in this research.

Residential Survey Instrument

A survey instrument was designed to assist in understanding livability and identifying the impact of freight on livability. The survey was administered in both online and focus group formats, with the focus group sessions specifically targeting residents living near the Lamar corridor. Both the online survey (administered via an email invitation) and the focus group sessions were facilitated through a partnership with Livable Memphis, a nonprofit organization that maintains relationships with neighborhood associations throughout Memphis, TN. Through this partnership, neighborhood leaders assisted with the online dissemination of the survey to even more residents both within and outside of the study area. The intent of the broader administration effort was to obtain feedback from residents of NFC areas of Memphis to allow the performance of a comparative analysis. For the FC residents, the survey instrument was issued both printed and in-person to community groups in Parkway Village (two sessions) and in Hickory Hill. The first session was on October 9, 2013, the second on March 4, 2014, and the third on March 11, 2014. The five neighborhoods that are found within the study area are Oakville, Oakhaven, Parkway Village, Fox Meadows, and Hickory Hill (Figure 7).

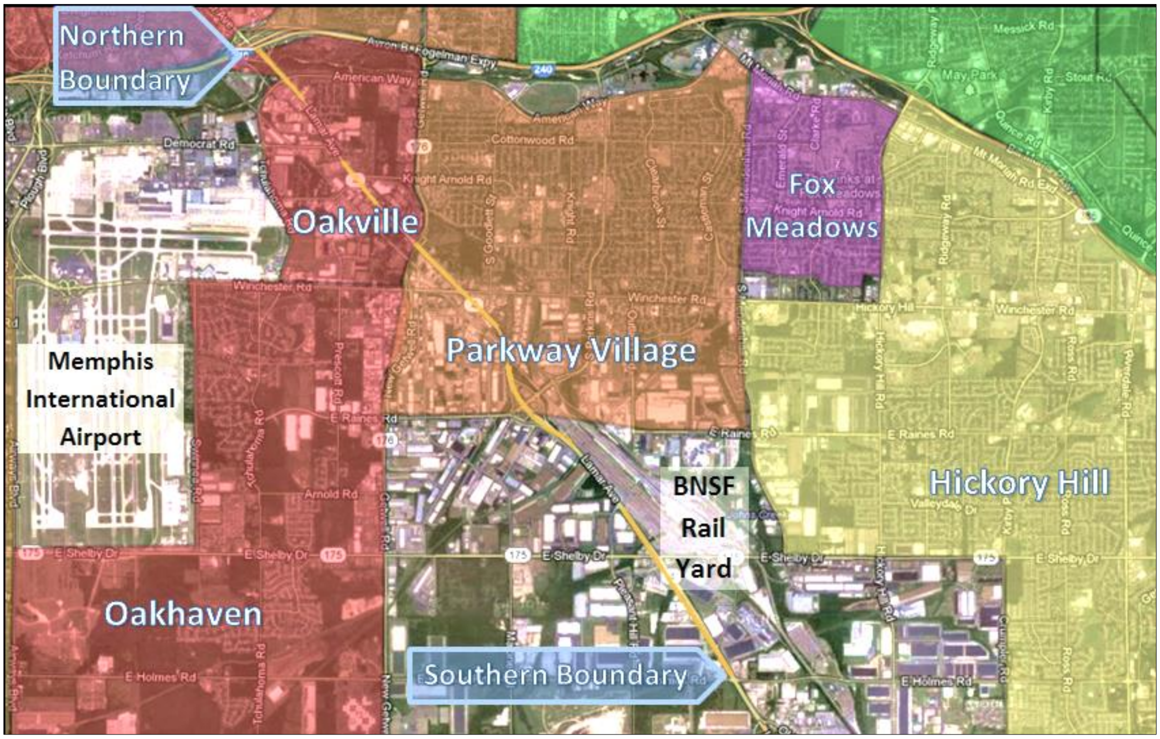


Figure 7 Lamar Avenue and Bordering Neighborhoods (Google maps)

Responses from the focus groups and online survey events were used to identify factors affecting livability of FC and NFC communities, relative importance of these factors, and perceptions regarding the impact of high freight volumes in a neighborhood.

The comprehensive survey included a number of open-ended, ranking, and rating questions that explored the residential opinions regarding how freight traffic affects the livability of their neighborhood. Participants were asked for information about their perceptions of how their neighborhood has changed over time, what livability means, what the contributors and barriers to livability are, and what factors need improvement in their neighborhood. Table 3 describes the neighborhood perception survey items and indicates the question type.

Table 3 Residential Survey Questions Regarding Definitions of Livability and Perceived Barriers of Livability

#	Survey Question	Type
1	Please tell us the closest intersection to where you live:	Short Answer
2	How has your neighborhood changed since you have lived here?	Open-ended
3	How do you define livability for your community?	Open-ended
4	In your opinion, what things are important for making a community livable?	Open-ended
5	In your opinion, what things are barriers to livability?	Open-ended
6	How do you rate your neighborhood for livability? 10 being very livable.	Rank 1-10
7	What are the most important contributors to livability? (Please pick your top 5 most important.) • Having a park in my neighborhood • Living close to school/work • Living near a hospital • Having a community center • Knowing my neighbors • Feeling safe in my neighborhood • Having alternative transportation options (walking, biking, public transit) • Living in an economically thriving neighborhood • Having a sense of community • Having a voice in my neighborhood • Having a say in what happens in my neighborhood • Quality affordable housing • Minimal road congestion • Being able to walk to the grocery store • Clean air and water • Good roads • Good bus service • Public art/aesthetic surroundings • Landscaping	Choose 5
8	In terms of transportation (walking, biking, driving, and public transportation), what are areas that need improvement in your neighborhood?	Open-ended
11	How does freight traffic (rail, trucks, air) affect your neighborhood?	Open-ended
12	Have you experienced any negative environmental effects in your neighborhood (smog, pollution, or otherwise)?	Yes or No (and explain)
13	Do you attribute these environmental factors to the freight traffic in or around your neighborhood? Please explain.	Open-ended

After the initial focus group session in Parkway Village, adjustments were made to this instrument to address items that were not properly interpreted. The question, “How do you define livability for your community?” Was changed to, “In your opinion, what does livability mean for a neighborhood?” The original version prompted a numerical response, where the later version better influenced an open-ended response as intended. “What do you think is the impact of the freight presence in your neighborhood?” was changed to “How does freight traffic (rail, trucks, air) affect your neighborhood?” as the change in wording attempted to simplify the question.

From a transportation-related perspective, residents were asked about their personal commuting patterns (including whether or not a heavy freight presence alters these patterns), and they were also asked to evaluate transportation facilities around their neighborhood. Participants were questioned as to how the freight traffic on Lamar Avenue compares to other parts of the city, as well as what the impacts of this freight presence. Furthermore, they were asked to explain their current involvement with public/municipal leaders, and they were given an opportunity to describe needs in these areas in three open-ended questions. Table 4 presents the specific items contained within this section of the survey instrument.

Table 4 Residential Survey Questions Regarding Personal Commuting Patterns and Transportation and Public Policy Relationships and Needs

#	Survey Question	Type
9	Please tell us about your traffic experiences in the Lamar Corridor: How often do you notice the presence of freight or heavy trucks? How often are you stuck in traffic due to this freight presence? How often are you stuck in traffic not caused by freight?	0 Never 1 2 Just as often as elsewhere in Memphis 3 4 Extremely Often
10	Do you find yourself taking alternative routes to avoid the Lamar Corridor?	Choose Yes, No, Sometimes, or Other
14	What is your primary mode of travel? Walk Bike Bus/public transit Car/personal vehicle Carpool Taxi	Ranking
15	Do you feel safe/ secure using these modes of transportation? Please explain.	Open-ended
16	What do you consider most important in terms of transportation options? (Please rank- 1 is most important and 9 is least important) • Sidewalks and/or paths to shopping, work, or school • Bike lanes or paths to shopping, work, or school • Reliable bus or rail transportation • Reliable long-distance bus or train transportation to and from surrounding cities • Major roads or highways that access and serve the community • Easy access to the airport • Pedestrian-friendly streets • Adequate parking • Minimal road congestion/ delay	Ranking
17	How much importance do you think you hold to industry leaders/ municipal decision makers?	Open-ended
18	How much involvement do you have with industry leaders/ municipal decision makers?	Open-ended
19	Would you be willing to become more involved in the decisions made by industry and policy decision makers in or around your neighborhood?	Open-ended

These questions, joined with a demographic section (Table 5) provided insight on the residential perceptions about freight and livability characteristics. The overall residential survey also provided insight into the effectiveness of using livability as terminology.

Table 5 Residential Questions Regarding Demographic Information

20	Are you currently renting or do you own your home/apartment?
21	Do you work at a business on or near Lamar Avenue?
22	How old are you?
23	Which of the following race/ethnicity do you best identify with?
24	Including yourself, how many people currently live in your household?
25	How many children live in your household?
26	Are you married, separated, divorced, widowed, or have you never been married?
27	How many vehicles are owned, leased, or available for regular use by the people who currently live in your household?
28	What is the highest level of education you have completed?
29	Are you employed full-time, part-time, not employed for pay at the moment, retired, or a student?
30	How many years have you lived in this neighborhood?
31	Would you say your neighborhood is very safe, somewhat safe, or unsafe?
32	During the last calendar year, about how much was your total family income before taxes?

Upon collection of data for this survey instrument, a selection of questions that most aptly addressed the following concerns was chosen in order to most appropriately answer to the purpose of this research:

- Are the priorities and barriers to livability different between FC communities and NFC communities?
- Does freight have a significant impact on livability perceptions?

Methodology for Statistical Analysis

Two main statistical tests were used to comparatively analyze the differences between the FC and NFC samples of data obtained from this survey instrument, the Chi-Squared test for categorical data sets and the nonparametric test, Wilcoxen's Rank Sum test for ordinal data sets. Many of the most appropriate and informative survey items where open-ended. Commonalities among the answers in both samples allowed for categorical analysis after the frequencies of each response were recorded for both the FC and NFC groups. Most of the individual respondent's answers spanned multiple categories, so the totally frequency of responses may be higher than the total number in the sample.

To analyze the statistical differences between the FC and NFC samples the Chi-squared (χ^2) test was used for certain survey items that yielded categorizable frequencies of non-ordinal data. Contingency tables like the one shown in Table 6 were set up for each question.

Table 6 An Example of a Contingency Table Used in χ^2 Testing for the Categorical Frequency Analysis of Open-Ended Questions

	Category_1	Category_2	Category_3	⋮	
FC Frequencies					**Total FC**
NFC Frequencies					**Total NFC**
	Total_1	**Total_2**	**Total_3**	**…**	

The χ^2 test was performed to investigate whether or not the distributions of FC and NFC responses differed from one another.

Wilcoxon's Rank Sum (WRS) test was used for the questions that yielded a set of ordinal frequencies. This test compares the entire distributions rather than the median or mean of the distributions. WRS test is also known as the Mann-Whitney U test. The null hypothesis is that the two sample populations (FC and NFC) are identical, and the alternative hypothesis is that the two sample populations are different.

Results

The three focus group sessions and an online campaign yielded a set of 72 complete residential survey responses. Figure 8 displays the location of the closest intersection of the entire set of respondents. The yellow balloons represents a resident of a NFC portion of Memphis (n = 32) while the green balloons represent a resident of the FC community within the study are (n = 40). This section summarizes the results of the survey instrument. Results were collected from October 2013 through March 2014.

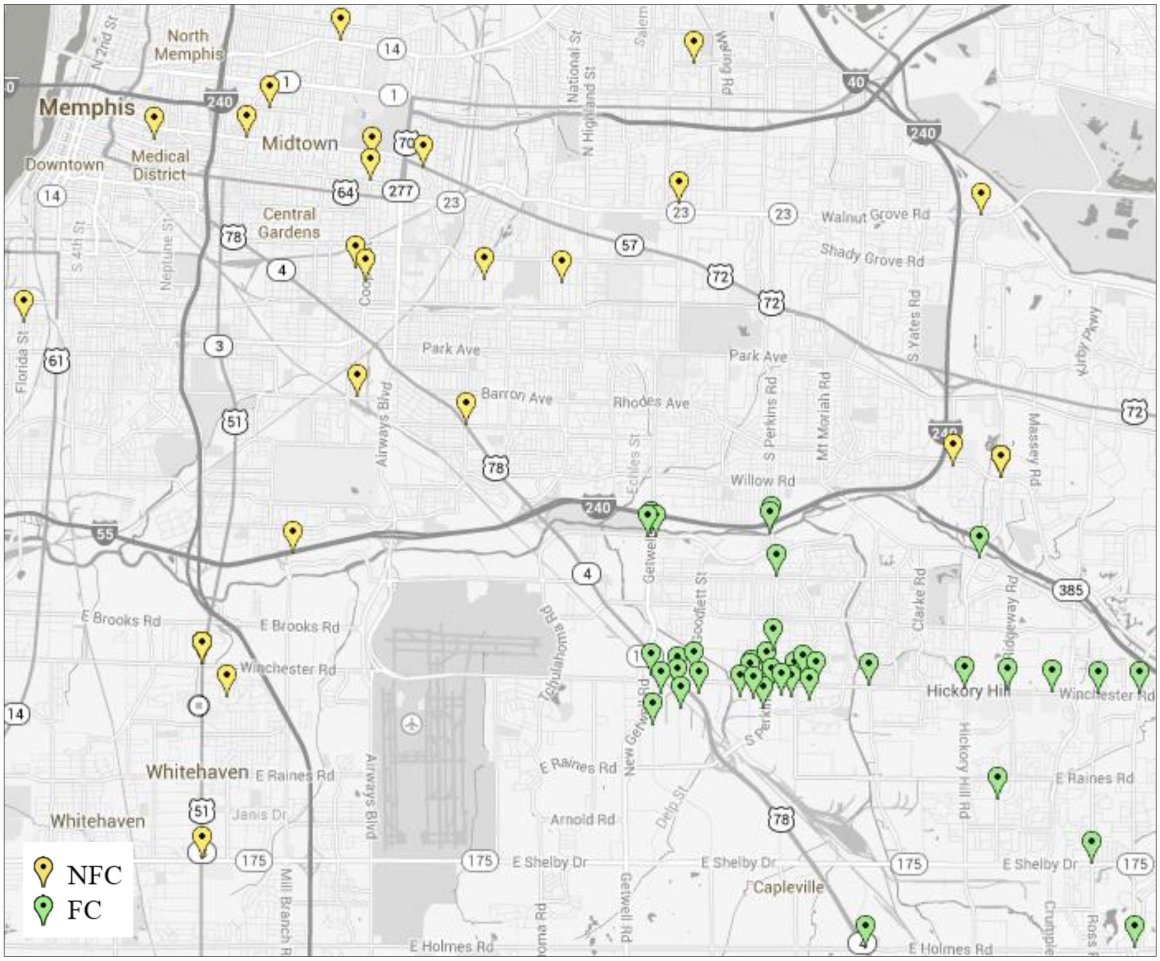
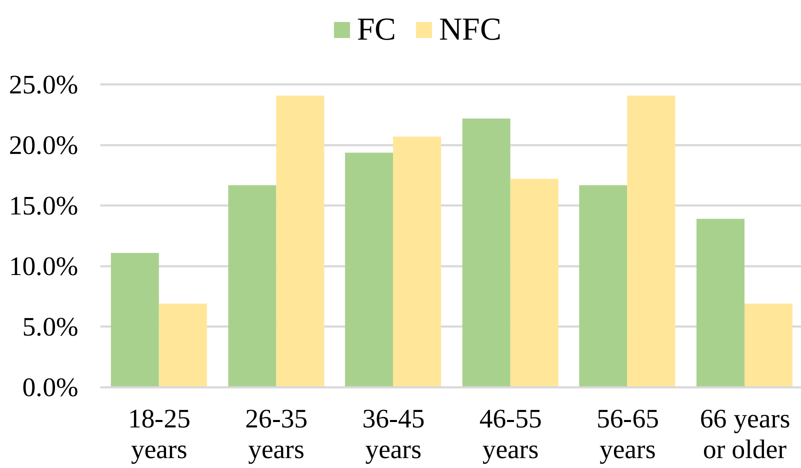


Figure 8 The Location of the Closest Intersection of Each Respondent's Residence (n = 72)

Demographics

Of all respondents, 55% of FC and 65.5% of NFC members are employed full- or part-time; while 12.5% FC and 0.0% of NFC are not employed for pay. The rest of the population is either retired or in school (32.5% of FC and 34.4% of NFC). The large majority of FC respondents, or 92.9%, are Black or African American, while for the NFC sample 51.9% are Caucasian and 48.1% are Black or African American. The age and income distributions for both groups are shown below in Figure 9.



Age (yrs.)	**FC**	**NFC**
18-25	4	2
26-35	6	7
36-45	7	6
46-55	8	5
56-65	6	7
66 or older	5	2
	n=36	n=29

Income	**FC**	**NFC**
Less than $15,000	10	2
$15,001 - $30,000	6	3
$30,001 - $50,000	11	7
$50,001 - $75,000	6	4
Greater than $75,000	4	10
	n=37	n=26

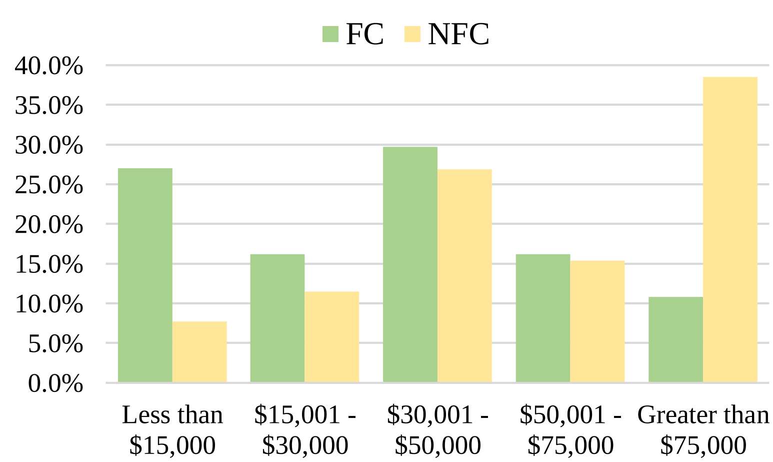


Figure 9 Age Distribution and Income Distributions of FC and NFC Respondent Population

Figure 10 displays the information regarding total number of people per household, total number of children per household, and total number of vehicles (leased or owned) per household.

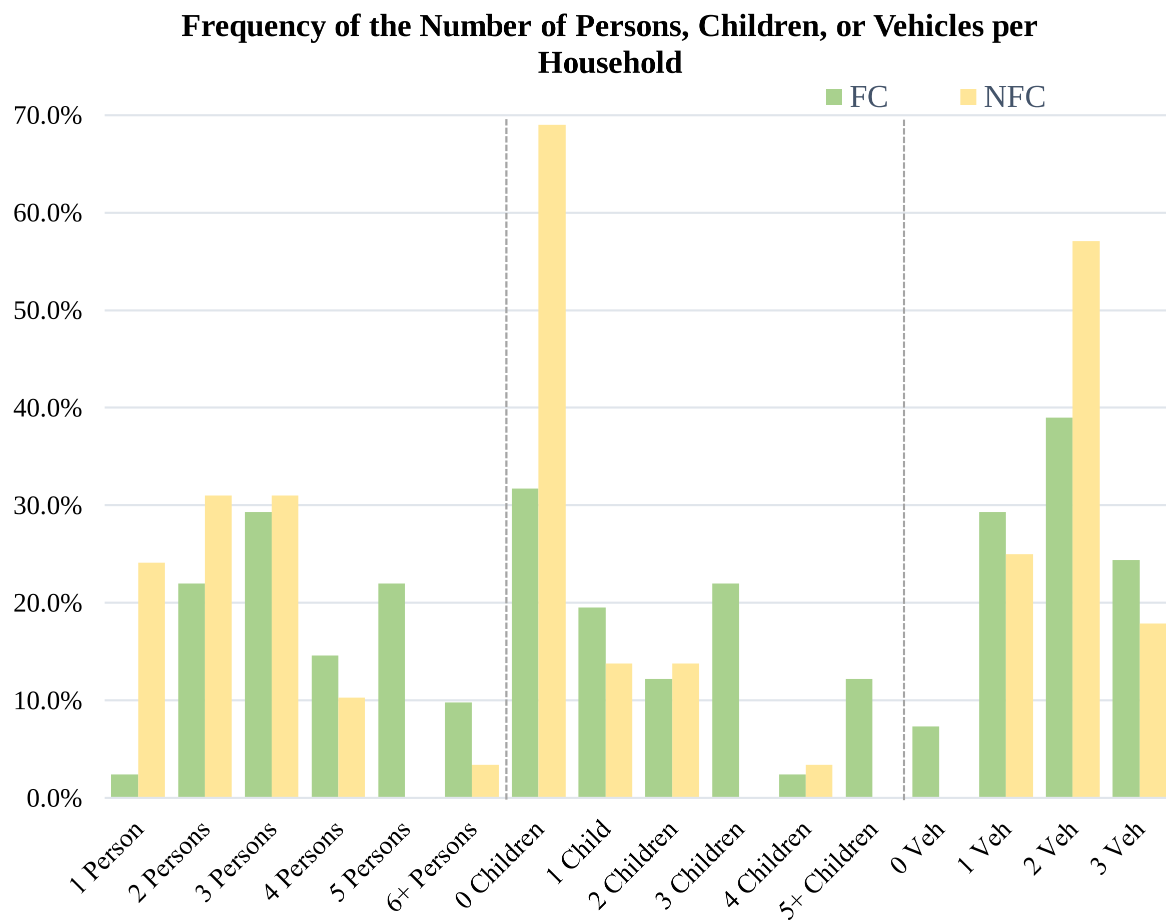


Figure 10 Number of People per Household, the Number of Children per Household, and the Number of Vehicles per Household for the FC and NFC Respondents

Livability Priorities and Barriers

In survey item 7 from Table 3, respondents were asked to choose five of what they considered to be the most important contributors to livability (from a list of 20). The results are shown in Figure 11. Statistical analysis of this data was performed in order determine if a significant difference existed between the opinions of the FC and NFC communities. Results yielded a χ^2 value of $35.8 > 30.1 = \chi^2(0.05; 19)$. The null hypotheis that there is no difference between the FC and NFC distrubtions was rejected, and therefore, a significant difference does exist in this case.

Open-ended responses for the next three survey items were analyzed by testing catagorical frequencies, again with this test. Respondents answered, “In your opinion, what things are important for making a community livable?” (Figure 12) and “In your opinion, what things are barriers to livability?” (Figure 13). Statistical analysis of the factors for livability data yielded a χ^2 value of $11.43 < 21.03 = \chi^2(0.05; 12)$. The null hypotheis of no difference between the FC and NFC variables cannot be rejected in this case. Similar analysis of the data regarding the barriers to livability yielded a χ^2 value of $16.82 < 23.69 = \chi^2(0.05; 14)$, so again the null hypotheis of no difference between the FC and NFC variables cannot be rejected.

When asked, “How has your neighborhood changed since you have lived [at your current location]?” common categories were formed and considered to be either negative, positive, or neutral or unknown (Figure 14). The χ^2 test for the entire data set yielded $52.01 > 33.94 = \chi^2(0.05; 22)$. The null hypotheis that there is no difference between the FC and NFC was rejected, and therefore, a significant difference does exist in this case.

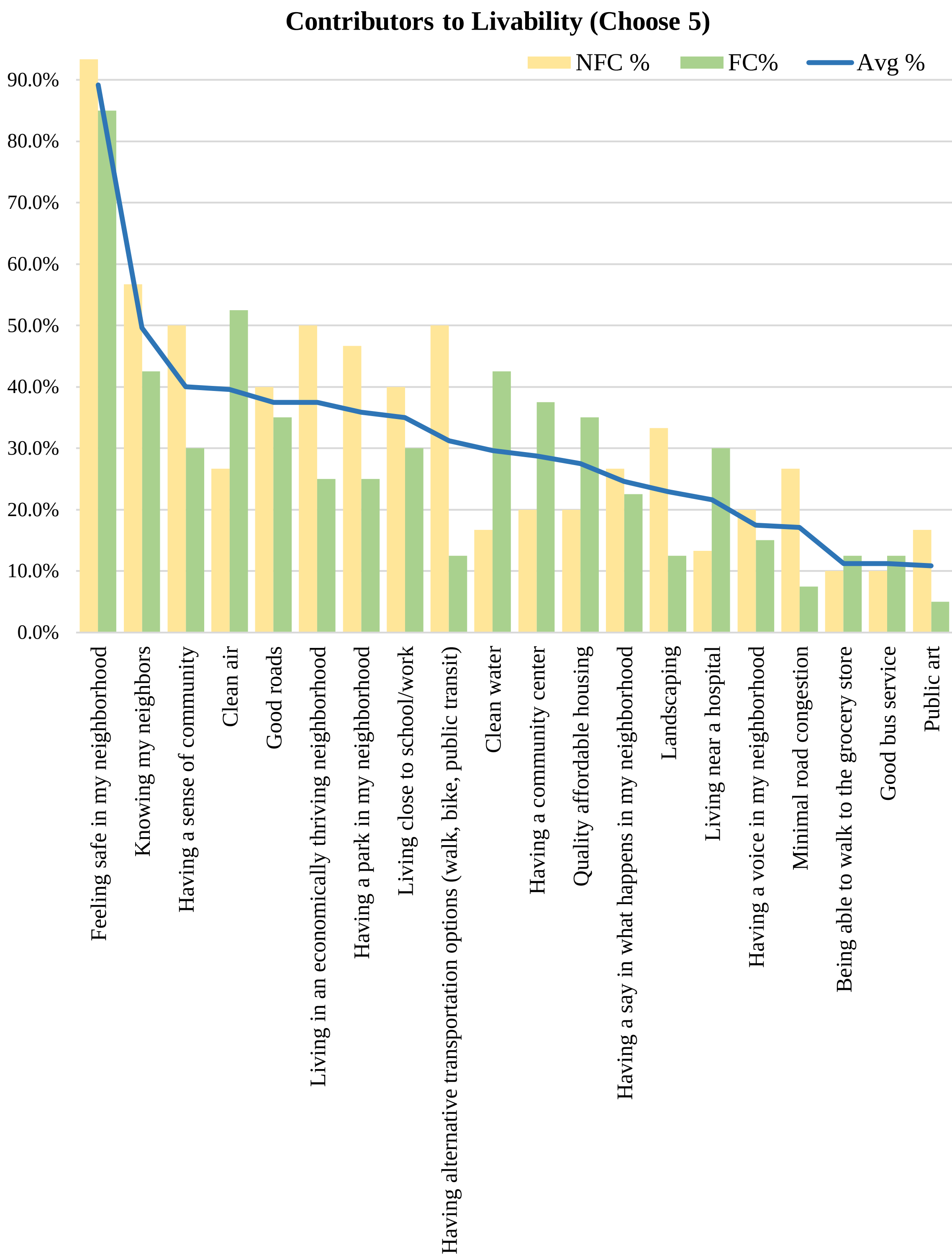


Figure 11 The Most Important Contributors to Livability

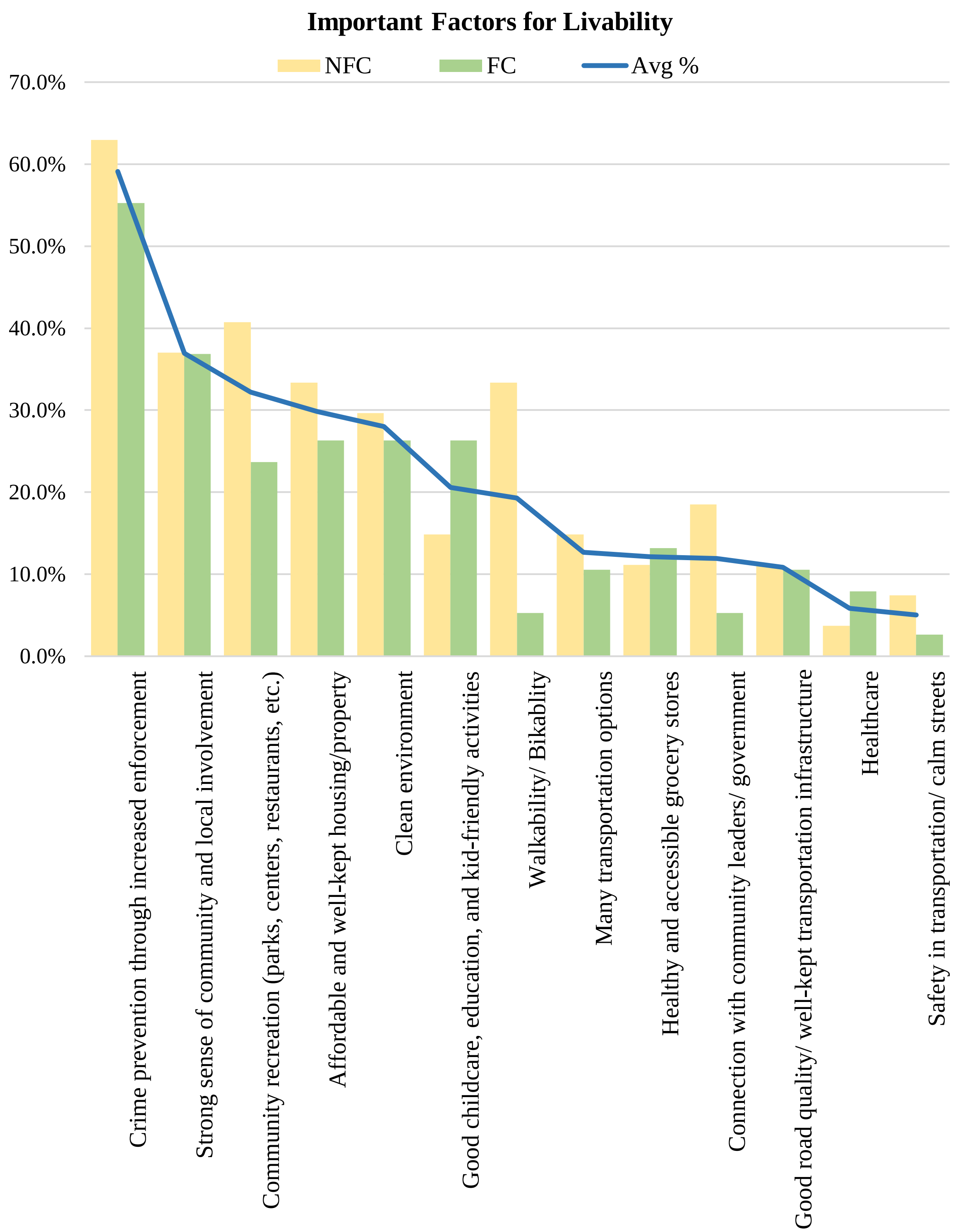


Figure 12 Important Factors for Livability (Categorized Open-Ended Responses)

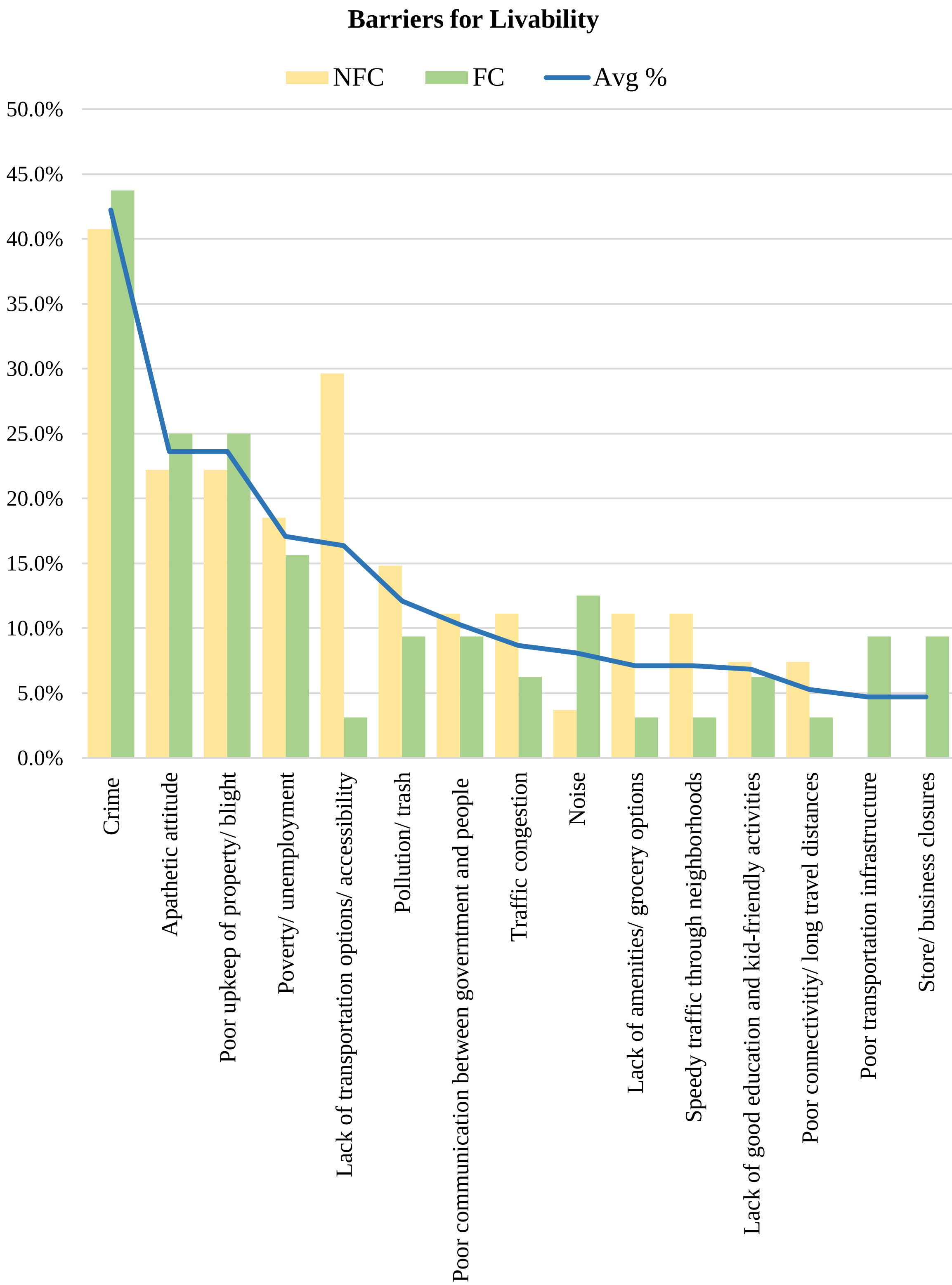


Figure 13 Prevalent Barriers for Livability in FC and NFC Communities (Categorized Open-Ended Responses)

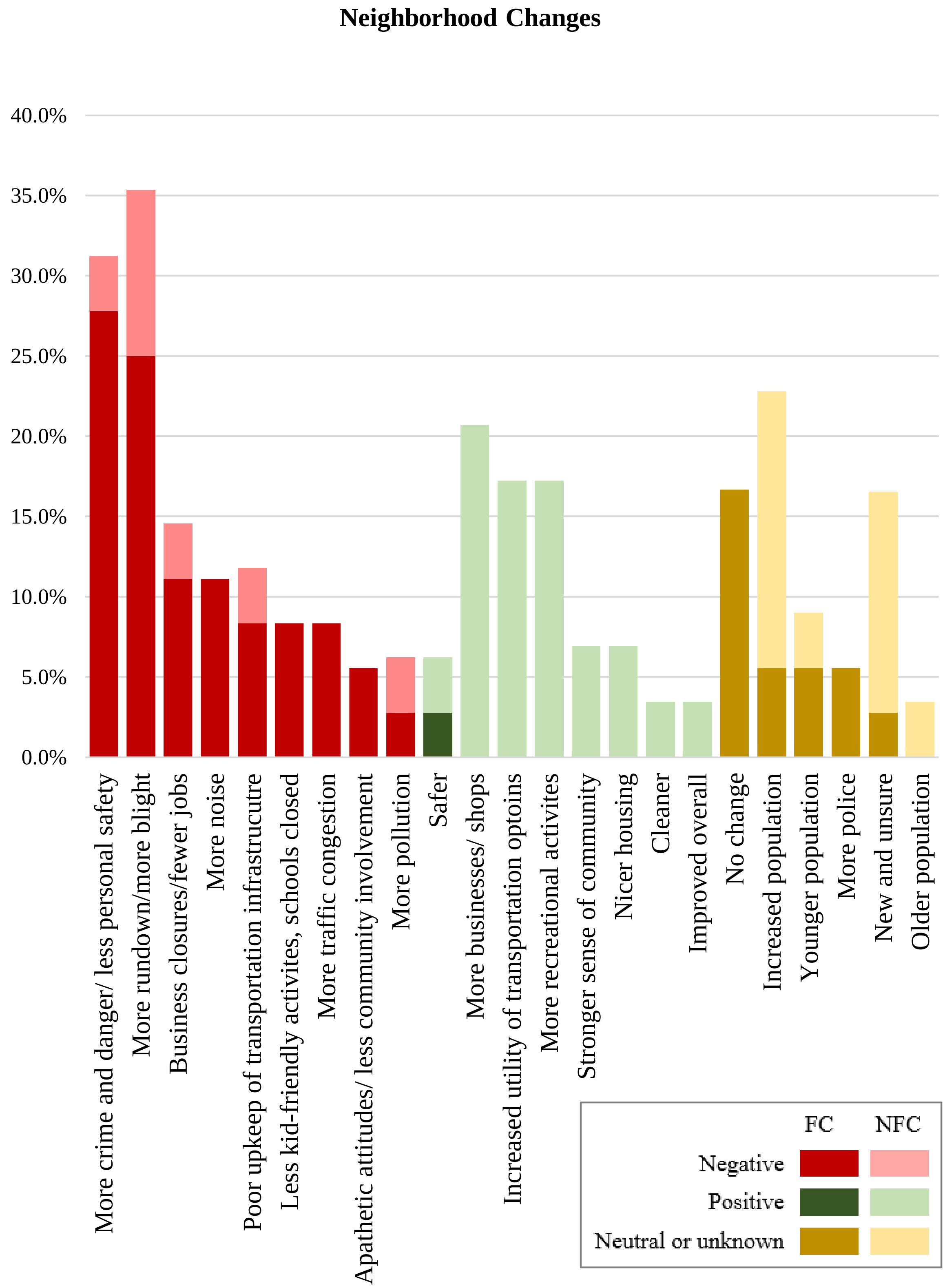


Figure 14 Open-Ended Responses for How the Neighborhood Has Changed Over Time Split into Negative, Positive, and Neutral or Unknown Groups

Using the WRS test, analysis was performed on the survey item in which residents ranked their neighborhoods on a scale of 1 to 10 (10 being the most livable). The results are shown in Figure 15.

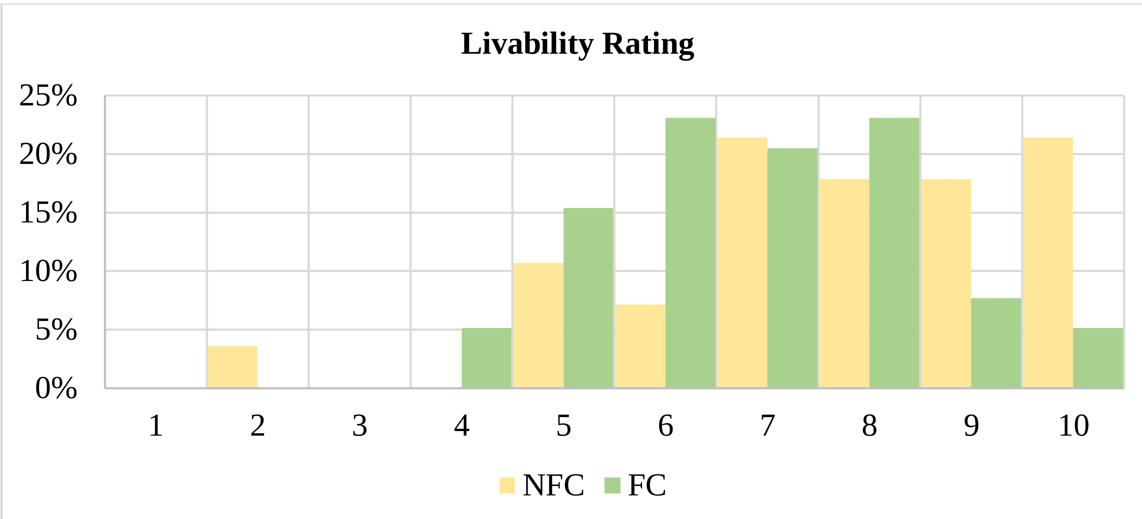


Figure 15 Response Frequencies for "How do you rate your neighborhood for livability? 10 being very livable."

With a Z statistic of $2.20 > Z_{\alpha} = 1.65$, the null hypothesis was rejected, and thus, the distribution of the FC and NFC responses are significantly different in this case.

Freight's Impact on Livability

Respondents were also specifically asked in an open-ended question how freight traffic affects their neighborhood. Results yielded a χ^2 value of $12.9 < 14.1 = \chi^2(0.05; 7)$. The null hypotheis of no difference between the FC and NFC cannot be rejected, and thus a signficant difference does not exist between the FC and NFC in this case (Figure 16).

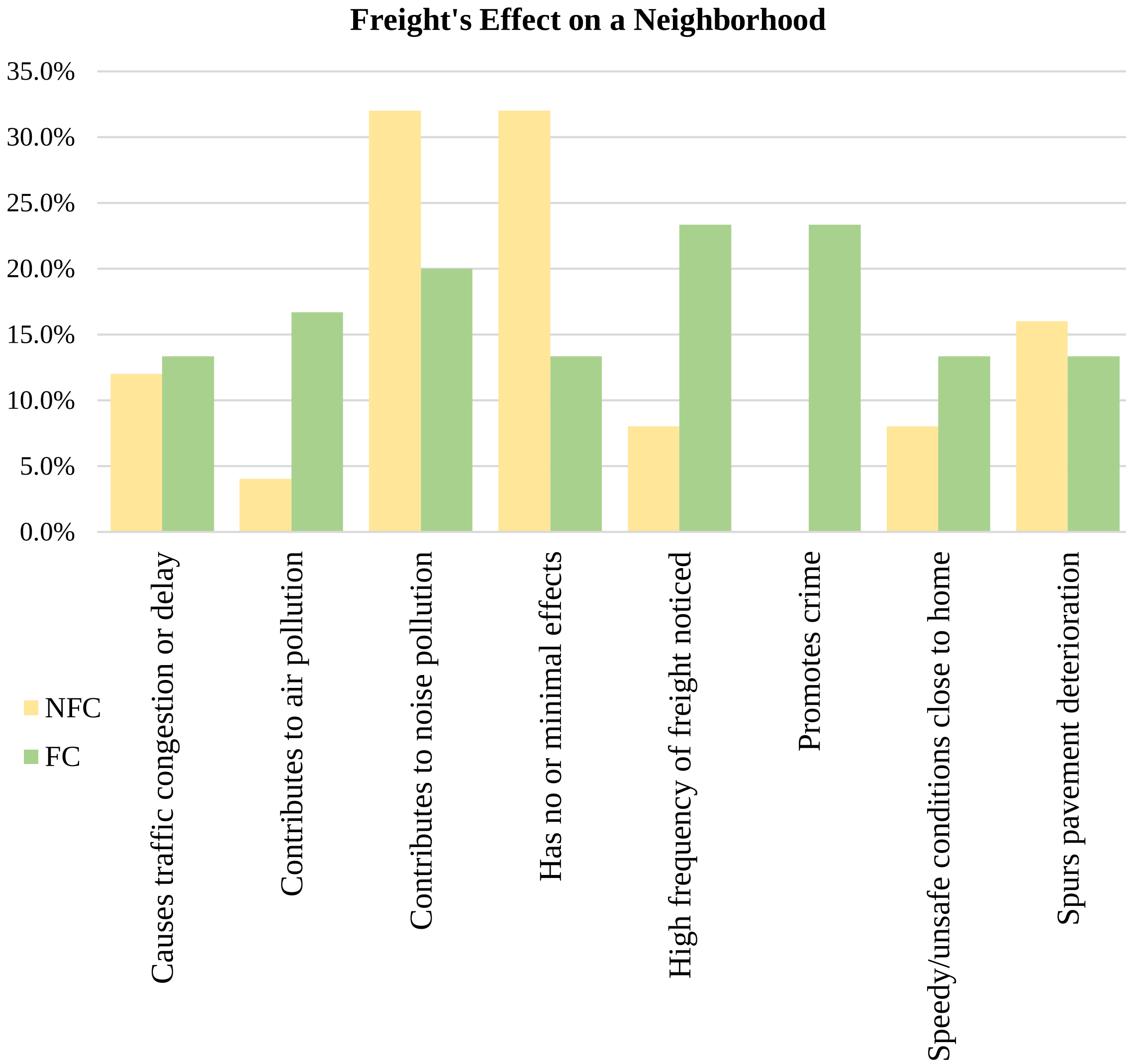


Figure 16 Categorical Answers for How Freight Affects the Respondent's Neighborhood

Additionally, respondents were questioned about how often they "noticed the presence of freight," and the WRS test was used for this set of ordinal data (Figure 17). A Z statistic of $1.00 < Z_\alpha = 1.65$ was calculated for this data, and thus the null hypothesis was not rejected. The distributions for the FC and NFC responses are not significantly different.

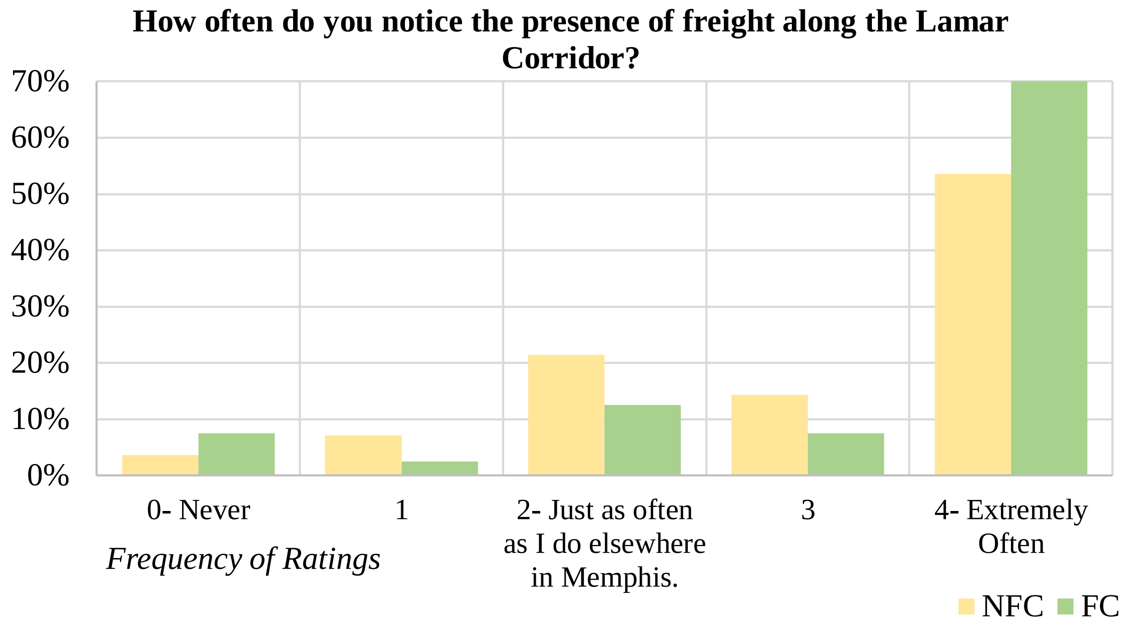


Figure 17 Frequency of Observations Regarding the Presence of Freight Traffic

Discussion

In an effort to promote livability in urban, FC communities, an understanding of what is important for residents' livability as well as what barriers impede residents' livability is required. This research explored these concepts through statistical comparisons between FC and NFC samples. Initially, an analysis was performed that focused on answering whether or not the priorities and barriers to livability are statistically different between FC communities and NFC communities. Not only does this analysis illustrate the differences between the community types, but it also serves as an indication of whether or not heavy freight volumes impact livability in a community. Furthermore, as commonalities emerged in the open-ended data responses, it became clearer what priorities and barriers exist for both types of communities.

Top Five Contributors for Livability

Respondents were asked to identify the most important contributors for livability from a list of 20 options, the results of which yielded significantly different selections between the FC and NFC groups. The FC group identified the top five most important contributors as:

- feeling safe in my neighborhood,
- clean air,
- knowing my neighbors,
- clean water, and
- having a community center.

The NFC groups identified some different contributors:

- feeling safe in my neighborhood,
- knowing my neighbors,
- having a sense of community,
- living in an economically thriving neighborhood, and
- having alternative transportation options (for walking, biking, or public transportation).

This is interesting from the standpoint that while both groups value statistically similar barriers and important factors for livability, the FC group selected two environmental factors in their top five contributors and the NFC group focused on economic vitality within their community. This points to the inherent difference in community environment between FC and NFC areas. Open-ended response questions pertaining to the topics of important factors and barriers for livability, however, did not elicit differences between the groups. A larger sample size is needed to further investigate these findings.

Focus group discussions further identified a perception of FC residents that community leaders and officials address transportation infrastructure and general attention to needs of the community more for NFC neighborhoods than for FC neighborhoods. Aside from implementing measures that could mitigate air pollution or manage harmful emissions, it may be beneficial to increase efforts to engage FC residents in community planning activities and communication between residents and policy makers.

Factors Important for Livability

Identified through categorizing open-ended responses, the most important factors that contribute to livable communities in FC and NFC areas were found to be crime prevention through increased enforcement (increased police presence or neighborhood watch), a strong sense of community and local involvement, community recreation and activities, affordable and well-kept housing/property, a clean environment, and good childcare, education, and kid-friendly activities. In this case, the FC results were not significantly different from those of the NFC community. Alleviation methods that would be most effective to address freight impacts within these communities are those involved in minimizing harmful emissions from traffic congestion spurred by freight traffic.

Barriers to Livability

The most prevalent barriers to livability in the FC and NFC communities were crime, apathetic attitudes within the community, blight/ poor upkeep of property, poverty/ unemployment, and noise pollution caused by freight traffic. Again, the frequency of responses for FC respondents were not significantly different from those of the NFC community, who also identified lack of transportation options as a barrier. Since noise pollution is an issue for both communities, night time deliveries may not be an applicable technique within residential areas, but other congestion management strategies may be beneficial.

Perceived Change in FC and NFC Neighborhoods

Figure 14 shows that the FC community responded with mostly negative changes while the NFC community responded with mostly positive changes over time. Statistical analysis shows that the overall distributions of the two groups are indeed different. These results further the idea that while people in both the FC and NFC groups possess similar perceptions of what is important for livability, the reality in their communities is very different.

Perception of Freight Presence on Lamar Avenue

The WRS test showed that the distributions of the FC and NFC samples are the same for the question, “How often do you notice the presence of freight along the Lamar Corridor?” This is to be expected, as both groups were commenting on their traffic experiences around the Lamar Corridor.

Freight's Effect on Neighborhoods

The results of the question, "How does freight traffic (rail, trucks, air) affect your neighborhood?" show no significant difference for the FC community and the NFC community. While a large majority of responses simply noted a high frequency of freight in their neighborhoods without commenting on the effect, many other responses cited minimal to no effects. Notably, only FC responses attributed increased crime as a direct result of truck presence. The next most common responses included contributions to noise pollution, pavement deterioration, air pollution, and traffic congestion and delay. This is in accordance with the externalities cited in literature.

Ranking of Livability

As residents ranked their communities for livability, results between the FC and NFC groups were statistically different. Figure 15 shows that the distribution of the NFC community was higher than the distribution of the FC community. These results further the idea that the FC community sees significantly more negative externalities from the increased presence of freight in the community.

Conclusions

The goal of this research was to investigate factors that are important for an individual's perception of livability, in both the freight-centric and non-freight-centric community. Based on the outcome of this pilot-scale study it appears that while both FC and NFC residents recognize the important factors and barriers for livability of a community, FC residents are impacted significantly by freight externalities, and this alters their perceptions of livability in their respective neighborhoods. FC residents also perceive a difference in how government and community leaders address transportation infrastructure and community improvements between FC and NFC communities.

The inherent problems (and related solutions) of high freight volumes within a community can be organized into three overlapping categories of last-mile/first-mile urban goods movement, environmental impact, and trade node (the most relevant category to this particular research). Table 9 below summarizes the techniques found in literature that may serve to improve hindrances to livability, specifically ones caused by an increased presence of freight traffic in a community (Giuliano et al., 2013). In addition to the "Success Rating" and "US Applicability Rating" proposed by Giuliano et al., each method also received a "Relevance to Lamar FC Community" and "Memphis MPO Plan Score" score. The relevance factor applied was either a 0 or 1 based on whether or not the solution addresses an issue identified in the results of this study.

Because of the prevalence of freight in Memphis, Tennessee's economy and infrastructure, the city's metropolitan planning organization (MPO) has developed a Memphis Freight Infrastructure Plan that informed the Memphis MPO Plan Score. Methods currently recognized in the MPO plan received a score of 1 (Memphis MPO, 2014). Based on the total score in the last column, the following table could help identify strategies that may be most appropriate to consider in further research on improving livability for the freight-centric community in Memphis based upon possibility of success, applicability, and policies currently in place.

The presence of freight traffic in urban areas may yield significant economic benefits, but can also play a significant role in deteriorating livability of a community. It is important for planning and other municipal officials to investigate options for improving quality of life for all residents. This is of particular importance in communities where externalities of freight lead to diminished experiences, and engagement of community stakeholders, while challenging, is critical for addressing these issues and improving livability. Developing a common understanding of livability among residents, planning, and transportation agency officials may be a first step in developing a means for increasing collaborative approaches to improving livability.

Table 7 Mitigating Strategies with Effectiveness Rating and Applicability to Problem Type and the US - A Summary of Technology-Based or Strategy-Based Solutions to Treat Last Mile, Environmental Impact, and Trade Node Problems (Giuliano et al., 2013; Memphis MPO, 2014)

Type of Freight Problem	**Description of Solution**	**Success Rating**	**US Applicability Rating**	**Memphis MPO Plan Score**	**Relevance to this FC Community**	**Total Score**
Last-mile	Labeling or other certification programs	3	3	0	1	7
	Traffic and parking regulations	2	3	1	1	7
	Land use planning policies	3	3	1	1	8
	City logistics and consolidation schemes	1	1	1	0	3
	Off-hours deliveries	3	2	0	0	5
	Intelligent transport systems	2	2	1	1	6
Environment	Truck fuel efficiency and emissions standards	3	3	0	1	7
	Alternative fuels and vehicles	1	2	0	1	4
	Low emission zones	3	1	0	1	5
	Alternative modes	1	1	1	1	4
Trade node	Appointments and pricing strategies at ports	2	3	0	0	5
	Road pricing to manage hub-related truck traffic	3	1	1	1	6
	Accelerated truck emissions reduction programs	3	2	0	1	6
	Equipment management	2	2	0	0	4
	Rail strategies	2	2	0	1	5
	Border crossings	2	3	1	0	6

Recommendations for Future Study

While the results of this study are important for informing future research and considerations for improving livability of the communities surrounding the Lamar Avenue corridor in Memphis, TN, a major limitation exists in the limited number of responses received for this study. This and other factors identified during the research process lead to the following recommendations for future study:

1. It is essential to identify better methods for community engagement that work for diverse members of a community. The key obstacle faced in this research was in obtaining participants in the project. Only 72 respondents were obtained over the course of an entire year. Planning organizations and other government agencies (particularly Departments of Transportation) are constantly challenged with obtaining input on plans and projects from a representative sample of community stakeholders.

2. It is important to obtain a larger dataset to determine if differences (or not) identified through this project are representative of the larger Memphis and Lamar Avenue community. With a larger dataset, additional methodologies can be used to analyze the data and identify relationships between factors and perceptions of livability.

3. If a large enough sample size is obtained, there is value in investigating differences in responses and perceptions of community residents based upon gender, age, race, and other demographic data. Any differences may lead to recommendations regarding strategies for engagement, education, and approaches for addressing livability in ways that consider needs of all stakeholders.

4. Based on the definitions and identified priories of livability from this research, simulation of appropriate strategies may further elucidate the most beneficial approaches for improving livability in the communities along the Lamar Avenue corridor.
5. Future research should also investigate freight-centric communities in other cities and states in order to determine if a common definition of livability and community priorities is possible, or if these factors are community dependent.

While this has been a pilot-scale study, the ultimate goal is to incorporate all recommendations above into a larger-scale study and then to integrate within this a measurement methodology that will provide a quantitative assessment of freight-centric communities using existing data related to influential factors affecting livability.

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Friday, April 11, 2014 at 8:20:18 AM Central Daylight Time

Subject: IRB Approval2731

Date: Friday, July 26, 2013 at 9:18:11 AM Central Daylight Time

From: Institutional Review Board (sent by Lavysia Lamai Richmond (llrchmnd) <llrchmnd@memphis.edu>)

To: Stephanie S Ivey (ssalyers)

Hello,

The University of Memphis Institutional Review Board, FWA00006815, has reviewed and approved your submission in accordance with all applicable statuses and regulations as well as ethical principles.

PI NAME: Stephanie Ivey
CO-PI:
PROJECT TITLE: Making Freight--Centric Communities More Livable
FACULTY ADVISOR NAME (if applicable): N/A
IRB ID: #2731
APPROVAL DATE: 7/25/2013
EXPIRATION DATE:
LEVEL OF REVIEW: Expedited

Please Note: Modifications do not extend the expiration of the original approval

Approval of this project is given with the following obligations:

1. If this IRB approval has an expiration date, an approved renewal must be in effect to continue the project prior to that date. If approval is not obtained, the human consent form(s) and recruiting material(s) are no longer valid and any research activities involving human subjects must stop.

2. When the project is finished or terminated, a completion form must be completed and sent to the board.

3. No change may be made in the approved protocol without prior board approval, whether the approved protocol was reviewed at the Exempt, Exedited or Full Board level.

4. Exempt approval are considered to have no expiration date and no further review is necessary unless the protocol needs modification.

Approval of this project is given with the following special obligations:

Thank you,

Ronnie Priest, PhD

Institutional Review Board Chair

The University of Memphis.

Note: Review outcomes will be communicated to the email address on file. This email should be considered an official communication from the UM IRB. Consent Forms are no longer being stamped as